

HOW IT WORKS

Games consoles

Games consoles have been around for longer than home computers, and the latest generation delivers incredible power. Simon Handby takes apart the current crop

In last month's *How it Works* we examined the development of Microsoft's DirectX, a set of technologies that helps to make the PC a powerful platform for multimedia and games. Of course, video games were around long before home computers became commonplace, as were the first home video games consoles.

The first ever games console was the Magnavox Odyssey, which went on sale in the US in 1972. It, and other early consoles, contained dedicated hardware that could run only the game or games pre-programmed into the device. When you had mastered the game, you had mastered the console.

Many people's first experience of gaming in the home is likely to have been on Atari's 2600. It was released in the late 1970s and is widely credited with being the first popular home console to contain a general-purpose processor, capable of running games contained within read-only memory (ROM) on cartridges.

As the console was able to run any game that was designed for it, manufacturers could continue to release games for the platform after its launch. This helped to keep customers interested in the console, extending its life, but it also gave the manufacturer a steady stream of income as it produced or licensed new games. With these twin benefits, it's not surprising that consoles are still designed and sold on a similar model, where powerful hardware runs games that are supplied on a disc or cartridge.

POWERING ON

Video games consoles have come a long way since the early models, which ran simple line-drawn games that typically used a handful of colours, if any, and had basic bleeps for a soundtrack. Most authorities agree that games consoles have passed through seven 'generations'. Each successive generation has been more powerful than the last, and the gamers using them have demanded more realism and complexity from their games.

Today's major home consoles – Nintendo's Wii, Microsoft's Xbox 360 and Sony's PlayStation 3 (PS3) – are hugely more capable than those that have gone before. The complex and immersive games available for each are made possible by powerful subsystems that work together to deliver a convincing experience.

PRETTY AS A PICTURE

For most people, the immediate impression a console makes is through the quality of its graphics. Today's consoles can all produce sophisticated 3D environments for players to explore, create, change or even destroy.

The Xbox 360 contains a custom graphics processor (GPU) designed by ATI. The Xenos chip is similar in some respects to the processor used

in Radeon HD2000-series graphics cards for the PC. Like DirectX 10-compatible cards, Xenos has a unified shader architecture (see *How it Works*, *Shopper 239*), allowing greater flexibility. Some sources allege that instability seen in some 360s is due to the heat produced by this powerful component, which is cooled by two fans. A recent production change to a smaller die size, resulting in a lower-voltage chip, may address this.

The RSX Reality Synthesizer GPU in the PS3 was designed jointly by Sony and Nvidia. On paper, its specifications and performance are broadly similar to those of the Xenos, although it's based on the G70 GPU of the previous-generation of GeForce 7 series PC graphics cards, which doesn't have the newest features, such as unified shader architecture.

Nintendo hasn't released the full technical specifications of the Wii's ATI-designed Hollywood GPU. The company admits that it decided not to compete with Sony or Microsoft in terms of outright power, however, and many believe that the Hollywood is a revision of the Flipper GPU found in the 2001 GameCube. At a reported 243MHz, the chip runs at less than half the clock speed of its competitors.

Both the Xbox 360 and the PS3 can output 1080p high-definition video. All PS3s have a high-definition multimedia interface (HDMI) connection, as do Elite versions of the 360 and Premium versions built since July 2007. The Wii can output only a maximum 480p signal, which is not high enough to qualify as HDTV.

WHEN THE CHIPS ARE UP

As with its graphics chip, Nintendo has not disclosed the exact details of the Wii's Broadway processor, although it is reported to derive from the Gekko chip used in the GameCube. Based on IBM's Power Architecture, it has a single core that is thought to run at 729MHz – about a third of the clock speed of a modern PC.

Broadway also seems slow compared with the Xbox 360's Xenon processor, which is clocked at 3.2GHz. The processor is based on IBM's PowerPC technology, and has three cores. Each core can process two separate threads in a similar way to Intel Pentium 4 processors with HyperThreading.

While PowerPC processors emerged in the early 1990s, and will be familiar to anyone who has a Mac built between 1994 and 2006, the 3.2GHz Cell processor used in the PS3 is very new. Developed jointly by Sony, Toshiba and IBM, Cell combines a general-purpose core based on IBM's Power Architecture with eight specialised coprocessors, which speed up certain dedicated routines. While this gives the processor incredible computing potential, developers need to assign routines to the coprocessors manually, and in general they regard the Cell, and hence the PS3, as comparatively hard to develop for.

Semiconductor manufacturing is incredibly intricate, and has a high failure rate. To increase chip yield, the PS3 uses only seven of the coprocessors, allowing for the failure of one during manufacture. One is reserved for system use, leaving six available for developers.

RAM RAIDERS

As you might expect for a system with a less-powerful processor and graphics chip, the Wii has the least memory of the three consoles. It has 64MB of DDR3 memory, with an extra 24MB integrated with the GPU itself.

The Xbox 360 and PS3 each have 512MB in total. On the 360 the full bank of DDR3 memory is available to either the CPU or GPU, but the PlayStation's memory is split between the two processors. The Cell processor uses 256MB of XDR RAM, which is the successor technology to the Rambus memory found in some early Pentium 4 PCs. The PS3's GPU uses 256MB of DDR3, although it can also access the CPU's memory if necessary.



▲ Sony's PlayStation 3 is as powerful as a high-end gaming PC

SUPER STORAGE

Before Sony released its original PlayStation, most consoles accepted games on ROM cartridges. These contained less information than could be stored on a CD and were more expensive to produce. Nintendo's N64, a contemporary of the PlayStation, was the last console to use cartridges; all consoles since have used optical discs.

As cartridge games grew in complexity, later games often included a small amount of flash memory for saving game data and the player's progress. The move to optical discs allowed for still more complex games that took longer to complete, so consoles began to use flash memory cartridges to store game saves. Many recent consoles, however, contain a large amount of rewritable storage.

Like the original Xbox, most versions of the 360 and the PS3 come with an internal hard disk. This ranges from 20GB to 120GB depending on the model. It's used to save game progress and user information, but also to enhance the performance of some games by pre-caching information from the optical drive to a faster medium. The Wii has 512MB of internal flash memory for similar purposes.

While the Wii's optical drive supports only proprietary Nintendo-format discs, the Xbox 360 has a standard DVD drive that reads game discs and plays audio CDs and DVD movies. For about £115 it's possible to buy an HD-DVD drive for the 360. The PS3, on the other hand, comes with a Blu-ray drive as standard. This makes the console great value if you're thinking of buying a Blu-ray drive anyway. However, early problems with the drive's copy protection delayed the console's launch by several months. A later shortage of blue laser diodes delayed the European launch further still.

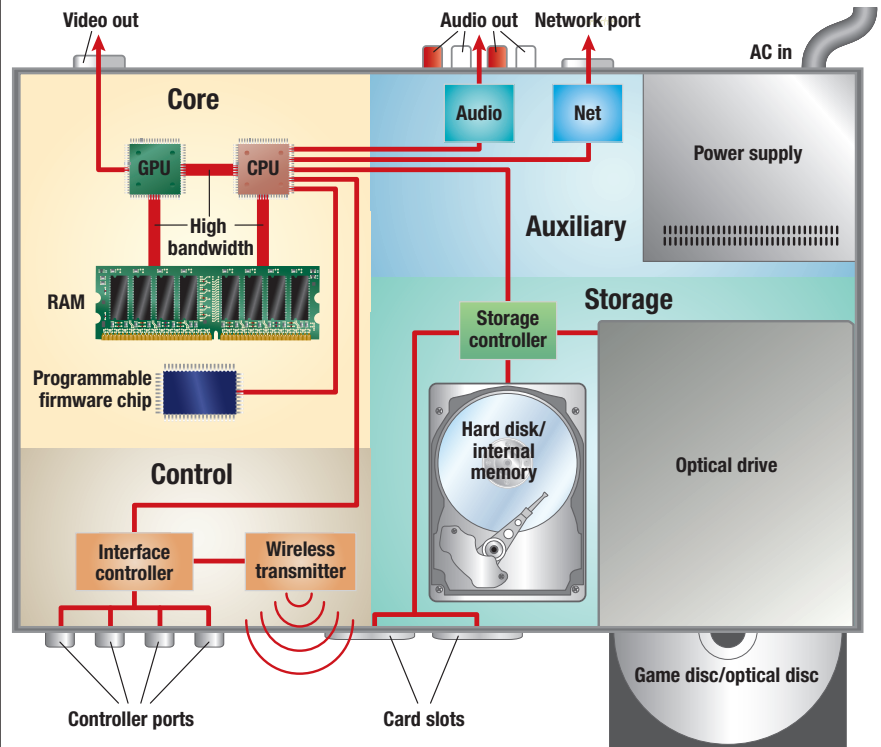
TEAM GAMES

Most developments in game console technology have concentrated on improving the quality of existing features, such as graphics and audio, but one particular development sets recent consoles apart from their predecessors. Until recently, gamers who wanted to play with, or against, each other had to play on the same console, using the same television and limiting the scope of multiplayer modes. While many games still offer this approach, today's consoles can communicate with each other through the internet, enabling massively multiplayer games.

Nintendo's Game Boy handheld consoles have always supported linked play through cables, infrared and, most recently, wireless networking. However, outside Japan, Sega's Dreamcast was the first full-size console to support linked play over a modem. Dreamcast games such as *Phantasy Star Online* were a success, but the original Xbox's standard Ethernet port and the arrival of Microsoft's Xbox Live service helped to establish online console gaming in most of the world. In the UK, both the Wii and PS3 have wireless networking as standard, but you need to buy a wireless adaptor for the Xbox 360 or use its Ethernet port.

The extra storage and internet connectivity has opened up modern consoles for more than straightforward games and movie playback. Console interfaces, which used to be little more than a screen that appeared when you forgot to insert a game, have become more sophisticated. Today's consoles enable you to play audio and

My generation The anatomy of a modern console



▲ Games consoles have increased in sophistication, and they now contain many of the components you'd expect to find in a computer, as this diagram shows. The system and graphics processors are as powerful as you'd find in a high-end gaming PC, and core devices communicate through very high-bandwidth data buses. Many components have been optimised for gaming and multimedia needs, while the console's streamlined and optimised operating system helps each subsystem work together to produce stunning games.

video content, or stream it from other networked devices, and to browse the internet.

The code that handles this level of functionality has evolved from simple firmware into full-blown operating systems. As with a PC's BIOS, essential low-level instructions are still contained in console firmware, but the higher-level functions are managed by slick software. Operating systems can be easily updated through game discs or the internet, enabling manufacturers to fix bugs and add or enhance functions on consoles they've already sold.

MOTION SLICKNESS

Another new development in this generation of consoles is the introduction of standard wireless controllers. Those for the PS3 and Wii communicate with the console via Bluetooth, whereas the Xbox 360 uses a proprietary 2.4GHz standard.

The Wii's controller (Wii Remote or sometimes 'Wiimote') looks radically different to others and underpins some innovative gameplay in the console's games. It contains an accelerometer that can detect movement along its three axes, and an infrared sensor that detects the position of the controller in relation to the console's Sensor Bar, which you place on top of your TV. The infrared system allows the Wiimote to work as an accurate onscreen pointing device and to work out its distance from the screen. This gives it rudimentary 3D position data, while its accelerometer enables its use to mimic physical actions, such as swinging a golf club or a tennis racket. The PS3's SIXAXIS controller has a more familiar shape, but it also contains accelerometers.

Both the 360 and the PS3 contain sound processors that support Dolby Digital in games and films, and DTS in films only. Each is capable of delivering up to 7.1-channel digital sound via a Toslink optical connector. The Wii supports analogue Dolby Pro Logic II processing, and can output sound only through RCA connectors.

WII VICTORY?

Despite having less power than the Xbox 360 and PS3, the Wii has sold faster than either. With more than 13 million sales worldwide it is currently neck-and-neck with the Xbox 360, which was released a year earlier. Fewer than six million PS3s have been sold.

This appears to vindicate Nintendo's deliberate policy to concentrate on the user interface and gameplay over raw power. In November 2006, games industry legend Shigeru Miyamoto told *BusinessWeek*: "Power isn't everything for a console. Too many powerful consoles can't coexist. It's like having only ferocious dinosaurs. They might fight and hasten their own extinction." 

FURTHER INFORMATION

Wikipedia entry on games consoles: http://en.wikipedia.org/wiki/Games_console

Games news & reviews: www.eurogamer.net

Games industry news: www.gamesindustry.biz

Developer's view on the difficulty of coding for PS3: <http://tinyurl.com/2jyl7n>

Unofficial list of Wii specs: www.maxconsole.net/?newsid=8802